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NUCLEAR FUSION EXPERIMENTAL APPARATUS
[Kaku yugo no jikken sochi]

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(54) NUCLEAR FUSION EXPERIMENTAL APPARATUS

SPECIFICATIONS /6

1. Title of the Invention

Nuclear Fusion Experimental Apparatus

2. Claim

Heavy hydrogen nuclear fusion experimental apparatus in which charging electrodes are installed in a reactor holding gas or liquid containing heavy hydrogen, and an ultrasonic generator for causing cavitation, pressure pump, or compressor is installed for application of high pressure to the gas or liquid in said reactor.

3. Detailed Specifications

Previously, experimental magnetic nuclear fusion, laser nuclear fusion, cold nuclear fusion using electrolysis, and other experimental nuclear fusion has been performed. This invention pertains to an experimental apparatus for nuclear fusion by applying a pressure element of pressure by ultrasonic wave cavitation or other means. This invention is explained below by its embodiments.

Figures 1 and 2 show an experimental apparatus for cold nuclear fusion by electrolysis that uses both implosion by cavitation and hydrostatic pressure by a pump or other means. In these figures, (1) is a metal disk base and (2) is a covered metal reactor on this base. (3) and (4) are pins for attaching the reactor to the base. (5) is a magnetostrictive vibrator about 1 cm in diameter comprised of a nickel bar and other parts. (6) is a coil attached onto this base such that it

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*Numbers in the margin indicate pagination in the foreign text.

can slide along the contact surface with the magnetostrictive vibrator. (7) is a disk-shaped electrode attached onto the magnetostrictive vibrator and comprised of palladium. (8) is a silicone rubber disk attached onto the coil, the upper surface of which is hollowed out into a cone. (9) is a glass tube attached onto this. (10) is heavy water placed in this tube, and to make this water conductive, lithium hydroxide, potassium hydroxide, oxygen chloride, or other electrolyte containing heavy hydrogen is added. (11) is a platinum electrode suspended from the upper wall of reactor (2). (12) is a ceramic insulating cover that surrounds the outside of this electrode. (13) is a porous oxidation catalyst inserted between the cover and the glass tube and comprised by affixing platinum to asbestos fiber. (14) is a space inside the upper wall of reactor (2). (15) and (16) are tubes connected to this space. (17) is a cavity within reactor (2). (18) is a power box installed within base (1). (19) is a cylinder filled with heavy hydrogen gas. (20) is an

electric pump connected to this cylinder. (21) is a tube space that /6
links this pump and cavity (17).

Next, operation and use of this embodiment are explained.

When pins (3) and (4) are removed, reactor (2) can be removed from the base (1) assembly together with electrode (11) and catalyst (13), heavy water (10) is infused into glass tube (9), and reactor (2) is covered.

Although not shown, a pressure regulation valve on pump (20) is set at several atm, and when the pump is activated, heavy hydrogen in cylinder (19) enters cavity (17) by way of tube space (21). Air in

cavity (17) is compressed by heavy hydrogen collecting in the upper part of the cavity, and is discharged from the space between base (1) and reactor (2) to the outside.

When no air is left, pins (3) and (4) are inserted, and when the contact surface between base (1) and reactor (2) becomes airtight, cavity (17) then is filled with heavy hydrogen under several atm pressure, and pressure of several atm is applied to heavy water (10).

Next, when a switch or the like (not shown) is operated, high-frequency alternating current of several 10's to several 100's kHz flows from power box (18) to coil (6), magnetostrictive vibrator (5) is made to expand and contract, palladium electrode (7) is made to oscillate up and down at the same frequency, and strong ultrasonic waves are generated in heavy water (10).

While these ultrasonic waves are generated continuously, a voltage of several 10's V from a direct current circuit within power box (18) is applied to palladium electrode (7) (the cathode) and platinum electrode (11) (the anode), these electrodes are charged, and by electrolysis, heavy hydrogen is generated at the surface of the palladium electrode and oxygen is generated at the surface of the platinum electrode.

Part of the heavy hydrogen generated dissolves directly into the heavy water. In particular, inside cavity (17) is subject to several atm of pressure, and the hydrogen generated dissolves easily into the heavy water.

Also, electrode (7) is affected by ultrasonic oscillation and generates cavitation in heavy water (10).

Now, when the speed of sound in heavy water is 1500 m/sec, the

distance between electrodes (7) and (11) is 30 mm, and the frequency of ultrasonic waves is 100 kHz, a stationary wave is generated between the two electrodes, two waves of 15 mm wavelength enter, nodes arise at a total of 5 locations at 3 locations between the two electrodes, and at these 5 locations, high pressure and negative pressure (hydrostatic pressure) alternate at a rate of 100,000 times per second.

During negative pressure, the heavy hydrogen dissolved in heavy water is vaporized to generate many bubbles. As these bubbles grow to a diameter of about 100 nm, because of surface tension and hydrostatic pressure acting on the boundary between the bubbles and the liquid, bubbles are suddenly contracted for a brief period of about 1 μs by so-called implosion, and the heavy hydrogen in the bubbles is compressed at a high pressure of several 100's atm.

This cavitation occurs even at the boundary between the heavy water and the surface of the palladium electrode, heavy hydrogen gas becomes compressed under high pressure, and the occlusive action of palladium on hydrogen atoms is accelerated, producing effects such as increasing the possibility of hydrogen being occluded at high density. As compared to heavy hydrogen previously generated only by electrolysis, greater compression of heavy hydrogen can be achieved by experimental occlusion of heavy hydrogen by palladium, and the possibility of nuclear fusion is increased. (The surface of the palladium is compressed by factors that include heavy hydrogen in the nascent state generated briefly during bubble contraction, plasma generated by temperature increase of several 1000's degrees due to implosion, and ionized heavy hydrogen. There also is compression merely by adsorption and hydrostatic pressure unrelated

to cavitation.)

Whether or not nuclear fusion has occurred may be evaluated by a neutron detector or γ-ray detector installed in cavity (17) or outside reactor (2), or by voltage applied to heavy water (10), ultrasonic wave energy, water temperature, or other measurements.

In these experiments, to cool the interior of reactor (2), cooling water is made to flow through tubes (15) and (16) and into space (14) in the upper wall.

Part of the heavy hydrogen and oxygen generated between electrodes (7) and (11) is compounded in heavy water (10) and returns to its original heavy water state. That which becomes bubbles rises within heavy water (10) and reaches catalyst (13), is reacted by catalytic action, returns to its original heavy water state, and falls into heavy water (10).

Consequently, there is no danger of oxygen entering cavity (17) and causing an explosion.

Because the hydrostatic pressure of heavy water (10) is pressurized at several atm, there is an increase in the maximum pressure generated by cavitation.

However, by altering the setting of the pressure regulation valve of pump (20), eliminating air within cavity (17) first, and then delivering the heavy hydrogen gas in the cylinder, cavitation may be made to occur at slightly lower pressure within cavity (17) and with slightly less ultrasonic wave energy.

Moreover, the embodiment described above permits various design /6 modifications.

For example, instead of magnetostrictive vibrator (10) [Translator's Note: error for "(5)"], an electrostrictive vibrator may be used, and a ceramic tube or metal tube covered by an insulating surface suspended from the perimeter of platinum electrode (11) to make it easier to generate an ultrasonic stationary wave within this vibrator.

Electrode (7) may be constructed of a porous material sintered of palladium particles 1 μm or less in diameter, or may be constructed of a desired material other than palladium.

For example, lithium and palladium sintered alloy, lithium and aluminum alloy, or any other alloy that promotes nuclear fusion with heavy hydrogen may be used, or upon adding lithium hydroxide containing heavy hydrogen until heavy water (10) is saturated, a crystal film of lithium hydroxide may be stretched over electrode (7).

Particles about 1 μm in diameter of palladium, lithium hydroxide, or other substances (in saturated solution) may be dispersed in heavy water (10) ahead of time such that implosion due to cavitation converges on the surface of these particles.

Silicone rubber disk (8) that blocks the bottom of glass tube (9) may be a thin metallic plate or other material. However, when the upper surface is hollowed out into a cone, particles added to heavy water (10) can precipitate easily onto electrode (7).

Charging between electrodes (7) and (11) may be performed at any selected phase by pulse charging at a frequency synchronous with the oscillation frequency of electrode (7), such that heavy hydrogen is generated by electrolysis during the contraction cycle of bubbles by

cavitation.

The entire apparatus may be placed in an extremely low-temperature environment, and instead of heavy water (10), cooled and liquified heavy hydrogen, mixed solution of heavy hydrogen and deuterium, or solution to which particles such as lithium, lithium deuteride, or palladium have been added may be placed inside, electrode (7) made to oscillate, cavitation made to occur, a high-voltage pulse applied between electrodes (7) and (11) at the same time as high pressure is generated, and the apparatus electrically accelerated by pressurized hydrogen colliding with electrode (7) due to cavitation.

In this case, the distance between electrodes (7) and (11) may be reduced, and the electrodes may be constructed of a substance such as lithium or lithium deuteride. (Lithium reacts easily with water, but resists reacting with liquid hydrogen.) Instead of heavy water (10), liquified hydrogen chloride, ammonia, or other substances may be used. (A small amount of heavy hydrogen may be dissolved in these solutions.)

Experiments also may be performed by inserting heavy hydrogen gas at room temperature and atmospheric pressure or low pressure without placing liquid in tube ([number omitted]), by omitting ultrasonic wave oscillation, by using a high-voltage direct current or pulse charging, or by heavy hydrogen ions colliding with an electrode (7) constructed of palladium, lithium, or an alloy of both.

The apparatus shown in Figures 3 and 4 shows a case in which high pressure is created by a hydraulic pulse. (22) is a metal frame. (23) is an insulating plate attached onto this and comprised of ceramic or other material. (24) is a hard metal cylinder attached onto this. (25) is a

disk-shaped palladium electrode about 1 cm in diameter attached onto the bottom of this cylinder. (26) is an insulating ring that surrounds the inner surface of the cylinder, is comprised of hard ceramic or other electrically insulated material, and has an upper part that is formed into a cone. (27) is heavy water placed into this ring. (28) is a piston above this. (29) is a hydraulic cylinder that is attached to frame (22) and encloses piston (28). (30) is a tube connected to the top of this cylinder. (31) is oil within this cylinder.

When this apparatus is used, oil (31) in cylinder (29) is drawn through tube (30) by a pump, piston (28) is raised, a fair amount of heavy water (27) to which lithium hydroxide or the like is added is placed in ring (26), oil (31) is infused into cylinder (29), piston (28) is pressed down, the bottom of the piston is brought close to electrode (25) while removing excess heavy water, and several 10,000's atm pressure is applied to the heavy water.

Next, the anode of a direct current source of several kV or a pulse power source of several 100's kV is connected to piston (28), electrode (25) is connected to the cathode, heavy water (27) is charged, the pressure on heavy water (27) is increased still more by the heat generated, and the heavy hydrogen generated presses against palladium electrode (25).

In this case as well, other materials may be selected for electrode (25) as desired.

The gap between cylinder (24) and insulating plate (23) may be widened, cylinder (29) and piston (28) may be of similar materials, and a hole may be installed in cylinder (24) such that electrode (25) is

pressed upward and heavy water (27) is compressed from both above and below.

Pressurized air may be delivered into cylinder (29) at the same time as heavy water (27) is charged by a high-voltage pulse, such that heavy water (27) is compressed by the shock of the air.

The apparatus may be designed such that a cylindrical hollow space 10 cm in diameter and 10 cm in length is installed at the center of each side of a steel ingot 1 m square, a conical hollow space the front of which reaches the center of the steel ingot is installed at the end of these hollow spaces, a central cavity 1 cm in diameter is installed at the center of the ingot, the inner surface near the central cavity is inlaid with palladium, the inside of the other hollow spaces is covered with insulating material, either heavy water or heavy water containing palladium colloid is inserted, a cylindrical piston just shy of 10 cm in diameter and 10 cm in length is partially inserted into each cylindrical hollow space to prevent leakage of heavy water, and all of the pistons are made to strike the central cavity by 6 air hammers at the same time as the heavy water is electrolyzed, causing implosion-type shock waves in the heavy water and generating high pressure in the central cavity.

In this case, the central cavity may be 2 mm in outer diameter and 1 mm in inner diameter, and lithium deuteride balls may be inserted within this under vacuum conditions so as to cause implosion and nuclear fusion.

These lithium deuteride balls may be replaced by carbon balls or the like, and may be created by artificial diamond synthesis or the like. Preferably, implosion waves are made to converge on the surface of

the balls by a means such as forming light depressions on the inner surface of the pistons.

This pressure may be applied from eight, twelve, or some other number of directions.

Figures 5 and 6 show an experimental apparatus in which linear charging is performed in pressurized hydrogen gas to cause each type of fusion. (32) is a cylindrical pressure-resistant reactor comprised of titanium alloy, zirconium, or other tough heat-resistant material 10 cm thick, 10 cm in inner diameter, and several meters in overall length. (33) and (34) are glass windows comprised of quartz or other material that block holes about 10 mm in diameter opened at each end of the pressure-resistant reactor, and that have the function of allowing ultraviolet rays to pass while being electrically insulating. (35) and (36) are metallic cylindrical electrodes that are placed in depressions on the inside of the glass windows, formed to a slight cone on their inner surface, and have conical central cavities about 10 mm in diameter at the outer end and about 1 mm in diameter at the inner end. (37) and (38) are lead wires that extend from these electrodes and project outside of reactor (32). (39) and (40) are tubes that pass into reactor (32). (41) and (42) are dye lasers or other ultraviolet lasers that produce an ultraviolet ray beam about 10 mm in diameter. (43) and (44) are ultraviolet lasers that produce an ultraviolet ray beam about 1 mm in diameter. (45) and (46) are excitation light sources for these lasers.

A gas mixture of heavy hydrogen and deuterium is loaded into reactor (32) through tubes (39) and (40) to create pressure of some

1000's to some 10,000's atm, light sources (45) and (46) apply pulse charging, lasers (41) through (44) are excited, and strong ultraviolet ray beams are generated along the axial direction of reactor (32).

The ultraviolet ray beams produced by lasers (41) and (44) [Translator's Note: error for "(42)"] are about 10 mm in diameter, and have the primary function that, after passing through glass windows (33) and (34), they enter the conical inner cavities in electrodes (35) and (36) and ionize some of the atoms in the hydrogen gas within these cavities to produce a conductive plasma.

The ultraviolet ray beams produced by lasers (43) and (44) are about 1 mm in diameter. Together with part of the beams produced by lasers (41) and (42), these pass through the small holes on the inside of electrodes (35) and (36), create a narrow plasma along the central axis of the hydrogen gas, and form an electric path that extends the metallic line between the two electrodes.

Although not shown, the anode of a capacitor power source connected to a direct current source of several 10's kV to several 100's kV is connected to electrode (35) by way of lead line (37), and the cathode is connected to electrode (36) by way of lead line (38). As a result, several coulombs to several 1000's coulombs of electrons flow from the capacitor in the direction of electrode (36) → electrode (35) through the hydrogen gas made conductive by ultraviolet radiation. Because their movement is impeded by their great mass, a small amount of heavy hydrogen and deuterium nuclei that become anions flow in the direction of electrode (35) → electrode (36).

Now, when 1 kq of electrons flows for a period of 1 μs between

electrodes (35) and (36) at a mean potential difference of 100 kV, this forms a mean current of 1 GA and generates 100 MJ of energy.

The electrified zone is raised in temperature, generates a large amount of electromagnetic waves, and is subject to thermal expansion.

Because most of these electromagnetic waves are irradiated onto the inner surface of cylindrical reactor (32), which is polished to a specular gloss, then made to reconverge along the central axis of reactor (32), these serve to raise the temperature in the central /6
part.

When the linear central part is raised in temperature, explosive thermal expansion occurs, shock waves widen in the radial direction, and these are irradiated onto the inner surface of reactor (32) and deflected in the central axis direction, where they reconverge.

As shock waves move toward the central part, their cylindrical wave front is gradually constricted in diameter, implosion occurs, high pressure is applied all along, and a linear part of superhigh pressure, high density, and high temperature is generated at the central part of hydrogen gas in reactor (32) that is in a state of high density close to being liquid. From this, the possibility arises of nuclear fusion of heavy hydrogen and deuterium nuclei.

When light sources (45) and (46) are charged and deliver ultraviolet ray beams inside reactor (42) at the same time that reflected waves of shock waves converge at the central part of reactor (32), after the voltage drops momentarily due to the previous discharge, current is supplied from the direct current source, recharging occurs from the capacitor power source that is restored in voltage, an

explosion occurs at the central part that is higher in temperature than before, and both the density and temperature achieved by implosion of reflected waves become higher than before.

When nuclear fusion generates heat, this rise in temperature becomes greater still.

Consequently, when pulse charging is reflected back to light sources (45) and (46), the temperature can be raised still more.

The energy sources that serve as factors in raising the central part to its maximum achievable temperature include light from lasers (41) to (44), charging electric power between electrodes (35) and (36), and heat generated by nuclear fusion. Energy dissipation routes that serve to lower temperature include thermal conduction from the central part to gas in outer parts, thermal conduction from gas to the reactor wall or other parts, absorption and permeation by the reactor wall of electromagnetic waves generated from the central part, and scattering of accelerated neutrons or helium nuclei generated by nuclear fusion.

Other factors in raising and lowering temperature include the diameter, length, and circularity of the inner surface of reactor (32); the reflectance of electromagnetic waves and shock waves; the shape and reflectance of electrodes (35) and (36); the thickness of ultraviolet ray beams; the capacity, voltage, and charging time of the power source capacitor; the phase and frequency during charging; the components, pressure, and temperature of the gas; the circularity, pressure on the constricted part, and thickness of shock wave fronts subjected to these factors; contraction of the discharge route due to the pinch effect; expansion of the discharge route due to impact and scattering of charged

particles during thermal dissociation or charging; and other influences.

Because of temperature rise due to recurrent charging, there is an increase in generation of phenomena such as x-rays, γ-rays, and neutrons that are not reflected by the wall surface of reactor (32), an equilibrium is reached between factors that raise and factors that lower temperature, and the temperature rise levels off at a constant value.

To the extent that the system is not charged with extremely great energy, even if nuclear fusion can occur in the central part with fairly high certainty, the temperature and density of the central part immediately drops due to thermal expansion, and all of the hydrogen gas within the reactor causes a chain reaction that does not extend to nuclear fusion.

Factors such as the amount of laser light flux, amount of charging current, internal pressure in the reactor, components of the gas, and timing of recurrent laser light irradiation may be varied to exercise the control needed to cause nuclear fusion.

Expansion waves generated extremely close to the inner side of electrodes (35) and (36) during charging expand in the radial direction, eventually strike the conical surface of the electrodes, are varied in direction according to the laws of reflection, and converge above the central axis of cylinder (32) apart from the electrodes.

Consequently, contraction waves from implosion do not converge near electrodes, and heating of electrode material is prevented.

Also, because the inner cavities of the electrodes are conical in shape and have a wide total surface area, the density of current permeating the surface and densities such as electron density and cation

density are low, heat is dispersed, and the electrode material can be prevented from melting.

Moreover, this embodiment also permits various design modifications. These are outlined below.

The size, pressure within reactor (32), charging conditions, and other values indicated can be raised or lowered as desired.

To cool or to remove energy, reactor (32) may be placed within a water bath or coolant may be circulated through cavities installed in the reactor wall, and hydrogen gas may be circulated in a radiator by way of tubes (39) and (40).

A number of fins may be attached to the outer surface of reactor (32) to increase the strength and heat radiating property of the reactor wall.

Lasers (43) and (44) may be designed to produce beams of greater diameter, these beams may be first micro-focussed by convex lenses, then modified to narrow parallel beams by concave lenses, or they may be delivered by lasers (41) and (42), in which case, the diameter of these beams is 0.1 mm or less.

When lasers (41) to (44) are charged electrically and a mechanical means used for excitation, light sources (45) and (46) are no longer needed. Ultraviolet rays may be produced by free electron lasers or other laser types.

Lasers (41) and (42) may be designed such that a wavelength type is selected that causes most of their output light to be absorbed by the gas in the cavities in electrodes (35) and (36), output light is delivered into reactor (32) at a slant, and the main body of the

apparatus is not placed in the track of the output light of lasers (43) and (44).

Instead of ultraviolet ray beams, x-ray or γ-ray beams produced by a synchrotron radiation generator or other apparatus may be used.

Visible light or infrared light lasers such as neodymium glass lasers may be used and hydrogen gas heated to high temperature such that it is made conductive by thermal dissociation.

Glass windows (33) and (34) may be made of a material that generates ultraviolet radiation on exposure to visible light, and light beams may be regulated by installing convex lenses or concave lenses on the boundary on the optical path between glass windows and electrodes (35) and (36).

To prevent local areas of high temperature on electrodes (35) and (36), metallic sodium solution or other solution may be placed in cavities installed outside of the electrodes or within the body of the apparatus, and this solution may be controlled and cooled by using convection or an external magnetic field to vary its fluidity or other properties.

The apparatus may be designed such that cylindrical metal ingots are placed in electrodes (35) and (36) that are about 30 cm in diameter and have a central axis that is 10 cm above the central axis of reactor (32), a number of holes about 10 cm in diameter are installed at locations 10 cm from the axis in the radial direction, a wagon-wheel-shaped internal electrode is formed, one of these holes is set such that light beams and current pass through it, and this internal electrode is rotated periodically such that discharge occurs from different holes to

avoid extreme rises in temperature.

The inner surfaces of electrodes (35) and (36) may be covered by insulating plates in which holes are installed only along the path of the electric current.

Thin metal tubes or carbon tubes evenly perforated inside with holes about 10 mm in diameter and several meters in horizontal length may be used as electrodes (35) and (36), and these may be charged by lead lines (37) and (38) connected to their outer ends such that they are roughly uniformly charged from the broad cylindrical inner surface that extends along the full length of both electrodes to prevent local areas of heating.

In this case, the charged particle beam from each electrode may be constricted to a conical shape by installing a convex electronic lens (convergent lens or the like) on the inner side of each electrode.

In addition, electrodes (35) and (36) must be fashioned so as to prevent heating or wear and tear.

To prevent charged particles passing through electrodes (35) and (36) from crashing into and clouding glass windows (33) and (34), the space between electrodes and glass windows may be opened, a magnetic field may be applied perpendicular to the axis of the optical path to bend the track of charged particles, or a device may be installed that automatically polishes away clouding, or synchronous to the rotation of the above-mentioned internal electrode, small replacement glass windows may be installed at places where charged particles strike.

By winding a coil around the outside of reactor (32) and charging this with a direct current, a magnetic field may be formed in the

horizontal direction that prevents the discharge route from widening.

Charging of electrodes (35) and (36) may be controlled by a thyratron or other switch. During this process, laser power sources and switches and other parts for electrodes (35) and (36) may be connected in sequence. Also, ultraviolet lasers in which a hot cathode and control grid are enclosed in a mercury vapor laser, the thyratron used with these, and electrodes (35) and (36), may be connected in sequence.

Several laser beams may be made to cross at one point within reactor (32) and each of the beams charged such that only the one point is raised to high temperature. In this case, each beam must use a separate power source and electrode.

The impact on piezoelectric elements attached to the outer surface of reactor (32) or the output of photoelectric cells or the like that receive electromagnetic waves generated in reactor (32) and leaking through glass windows (33) and (34) may be supplied by way of an A–D converter to a computer that computes the size, explosion starting point, and other aspects of any explosion or implosion occurring within reactor (32), and the apparatus may be controlled by means such as, after a set time has elapsed, having the computer generate a start-output signal that produces ultraviolet ray beams.

A large smooth capacitor may be installed that is connected to an alternating current source by way of a rectifier, and several pulse source capacitors installed that are connected to this smooth capacitor by way of each coil. When, synchronously with irradiation of laser beams, a switch is used to apply each pulse source capacitor in succession to electrodes (35) and (36), causing these to discharge, each

capacitor is recharged by the smooth capacitor during the interval before the next discharge, making it possible to discharge electrodes (35) and (36) repeatedly at a cycle of several kHz.

In this case, while one source capacitor is connected to electrodes (35) and (36), each coil is prevented from directly connecting electrodes (35) and (36) to the main smooth capacitor. In addition, no heat is generated such as in the case of resistors. When the smooth capacitor is connected directly, a large amount of current can pass through, but not only does this require more time for recharging, making it impossible to perform repeated charging in a short period, but the pulse width also becomes too wide. When the capacity of the smooth capacitor is constricted to a fixed value, alternating current source ripples become more pronounced.

Although this varies with the inner diameter and other conditions of reactor (32), the cycle of explosions occurring at the center, being reflected, and reconverging at the center is short and has a frequency of several kHz.

When the area around the central part is raised in pressure and temperature due to implosion, and thermal dissociation occurs, this area can be charged even without ultraviolet radiation. In this case, charging may be performed by a low-voltage, high-current source such that current flows with difficulty in the area apart from the central axis of reactor (32) where temperature is low and resistance is high.

Reactor (32) may be designed such that it is spherical with a central diameter of about 10 cm, it has a hollow center about 10 mm in outer diameter and 1 mm or less in inner diameter, the outer surface is

covered with insulation, several hundred pairs of long electrodes packed with quartz glass are distributed appropriately in this hollow center except in an area several cm from one end, the end not packed with quartz glass faces the center of the reactor and is attached to the center of the reactor wall such that it matches the inner surface of the reactor, the outer leads of each electrode pair in irradiation position are connected to an independent power source, ultraviolet ray beams are delivered through the quartz glass all at once, beams are made to converge at the central part within the reactor, charging is performed, the temperature at the central part is raised, and repeated recharging is performed during the interval that implosion waves converge at one point in the center.

In this case, when both the inner and outer diameters of electrodes are made thicker and only one to several pairs are used, convex lenses may be used to cause ultraviolet ray beams to converge at the center of the reactor.

Alternately, two semi-spherical reactors with flanges may be joined with a ring-shaped insulating plate in between and the two flanges affixed with a number of insulated screws, each reactor hemisphere may be connected to the anode and cathode of a power source, many narrow through-holes may be installed in each hemisphere facing the central part, these may be packed with quartz glass, and charging may be performed such that ultraviolet ray pulses are delivered through all the quartz glass and many ultraviolet ray beams pass between the two reactor hemispheres and converge at the center.

Spherical or cylindrical reactors are constructed of weakly

magnetic metal; the inside is packed with nitrogen, helium, purified water, or other fluid that is high in transparency and resists nuclear fusion; and several 10,000's atm pressure is applied.

A number of laser irradiation windows are installed in the reactor wall for converging laser light from lasers outside of the reactor onto the center of the reactor.

A fluid delivery port is installed at the upper end of the reactor, a drainage port is installed at the lower end, and fluid is allowed to flow within the reactor from the upper end to the lower end.

To form fuel pellets, a gas mixture of heavy hydrogen and deuterium is formed into balls several mm or smaller in diameter in an extremely low-temperature environment, and the outer surface of these is enclosed in a spherical reactor of weakly magnetic metal that is painted black.

These fuel pellets are delivered to the vicinity of the central part of the reactor by setting them in a stream of fluid delivered through the delivery port at the upper end of the reactor.

Weak light is delivered through the laser light irradiation windows or separate observation windows installed in the reactor wall, the position of pellets in the reactor is measured automatically, this is controlled by balanced charging of several electromagnets installed outside of the reactor, the position of pellets in the reactor is controlled by driving this magnetic force, and at the point when pellets reach the central part of the reactor, a strong laser pulse is delivered into the reactor through the laser light irradiation windows, instantaneously heating the surface of the pellets to a superhigh temperature.

According to the principles of standard laser nuclear fusion, the pellets cause implosion and generate nuclear fusion energy.

When pellets are placed inside the reactor from the delivery port, compressed hydrogen in the pellets tries to expand due to rising temperature, but because the fluid in the reactor is under high pressure, pellet expansion is prevented.

Pellets are evaporated and scattered by laser irradiation, but are absorbed by the surrounding fluid and expelled from the reactor together with the fluid, and therefore do not contaminate glass windows or the reactor wall as in previous laser nuclear fusion apparatuses.

Also, because laser irradiation is performed in a pressurized fluid environment, this also increases the maximum achievable pressure and maximum achievable temperature by implosion. /6

Moreover, in this case as well, pellets may be charged at the same time as laser irradiation by way of the laser optical path.

Pellets also may be created by means such as compressing pressurized hydrogen in a metal reactor for creating pellets in the same pressurized fluid environment as in the reactor, or by covering the surface of lithium deuteride balls with a metal reactor.

Other design modifications also are permitted.

When this invention is embodied, it has the advantage that in a nuclear fusion experimental apparatus that uses electrolysis or high temperature and high pressure, pressure can be applied at relatively low cost by different means than in previous methods.

4. Key to Figures

Figure 1 is a vertical cross section of the first embodiment of this invention. Figure 2 is a horizontal cross section of the same embodiment. Figure 3 is a vertical cross section of the second embodiment of this invention. Figure 4 is a horizontal cross section of the same embodiment. Figure 5 is a vertical cross-sectional elevation of the third embodiment of this invention. Figure 6 is a horizontal cross-sectional plan of the same embodiment.

Figure 1.

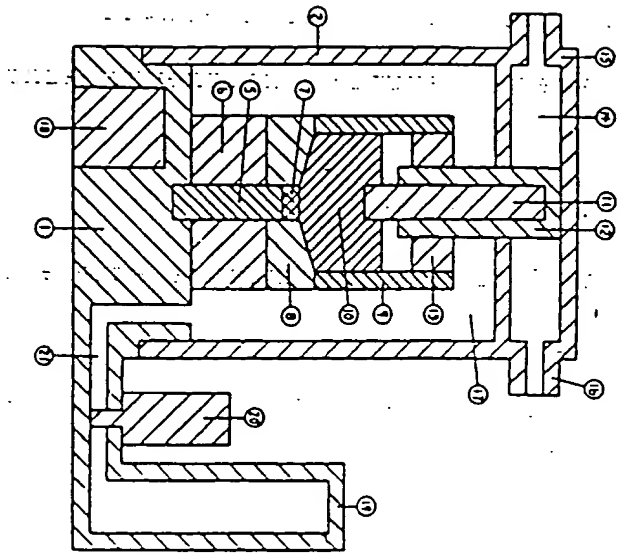


Figure 2.

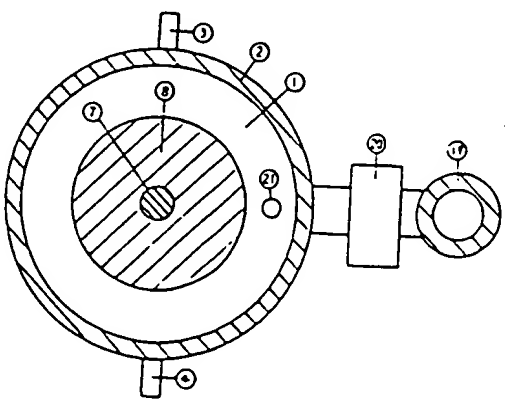


Figure 3.

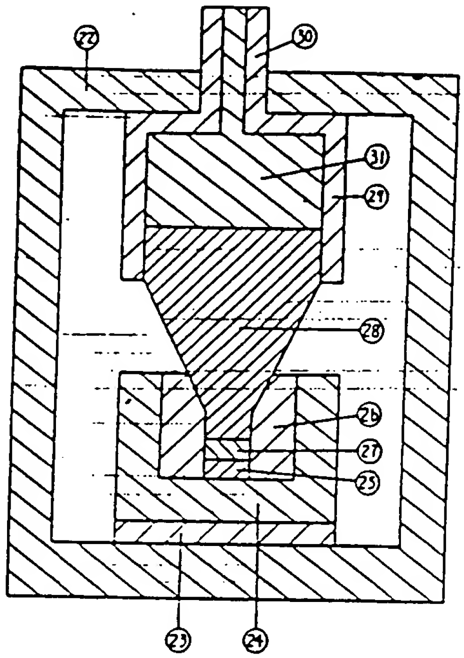


Figure 4.

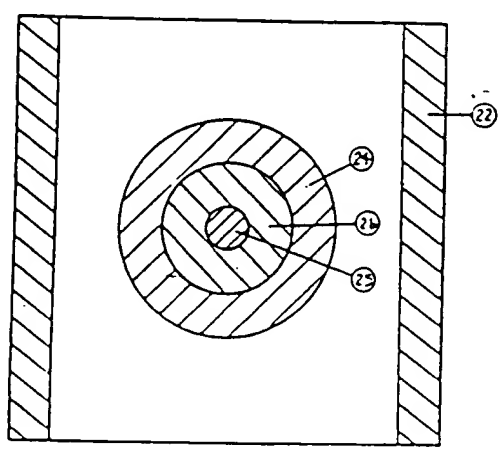


Figure 5.

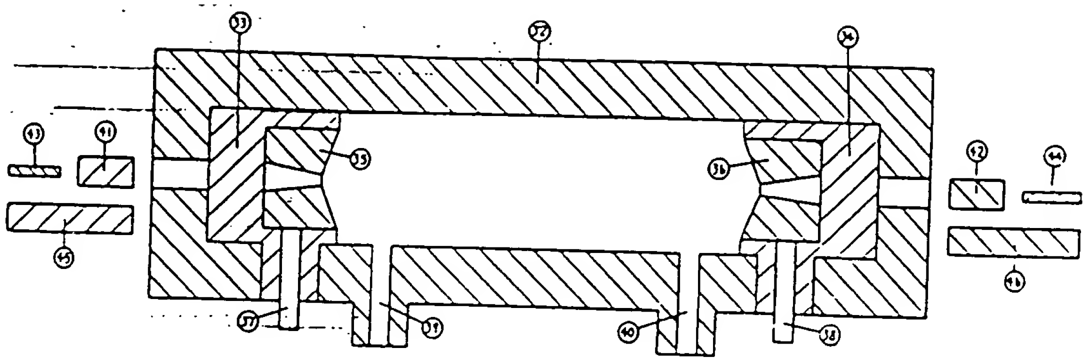
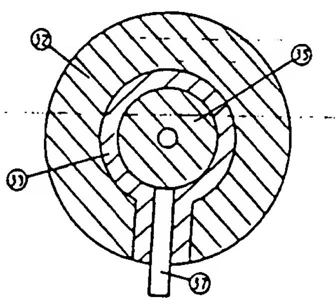


Figure 6.



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05.08.89-JP-203566 *(22.03.91)* G21b-01

Experimental nuclear fusion device - with electrodes in reactor vessel contg. heavy hydrogen and supersonic generator, pump or compressor

C91-055436

Experimental equipment is provided with electrodes in a reactor vessel containing gas or liquid including heavy hydrogen and a supersonic generator, a pressurising pump or a compressor for high pressure and cavitation.

USE - For a simple pressurising method to dissolve heavy hydrogen. (9pp Dwg.No.0/6)

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㊹発明の名称　核融合の実験装置

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明細書

1　発明の名称

核融合の実験装置

2　特許請求の範囲

重水素を含む気体または液体を納めた反応容器中に、通電用の電極を設け、該容器中の気体または液体に高圧を加えるための、キャビテーションを発生させるための超音波発生器、または加圧ポンプ、または圧縮機を設けて成る重水素の核融合の実験装置。

3　発明の詳細な説明

従来、磁気核融合、レーザー核融合、電気分解を利用した常温核融合、その他の実験が行なわれている。本発明は超音波のキャビテーションその他による加圧を加圧要素として付け加えた核融合の実験装置に関するものである。以下実施例に従い説明する。

第1～2図はキャビテーションによる加圧とポンプ等による静水圧加圧を併用した電気分解による常温核融合の実験装置を示し、図中(1)は金属円盤状の基盤。(2)はその上にかぶせた金属容器。(3)(4)は容器を基盤に固定するためのピン。(5)はニッケル棒その他から成る直径1cm程度の超音波振動子。(6)は基盤上に固定され、超音波振動子との接触面はスライド可能になっているコイル。(7)は超音波振動子上に取り付けた円盤形のパラジウムから成る電極。(8)はコイル上に取り付けられた上面が円錐形に凹んでいるシリコーンゴム製円盤。(9)はその上に取り付けたガラス管。(10)は管内に入っている重水で、導電性を与えるため、重水素を含む水酸化リチウム、水酸化カリウム、塩化水素、その他の電解質が加えられている。(11)は容器(2)の上壁から下垂しているプラチナ電極。(12)はその周囲を囲むセラミック製の絶縁カバー。(13)はカバーとガラス管の間に入っている石綿繊維にプラチナを担持させて成る多孔性の酸化触媒。(14)は容器(2)の上壁の内空。(15)(16)はそれに連なる穴。(17)は容器(2)内の空洞。(18)は基盤(1)中に設けた電線ボックス。(19)は高圧の重水素ガスを充填したボンベ。(20)はボンベに連なる電磁弁

ンプ。(21)はポンプと空洞(17)をつなぐ管路である。

次にこの動作や使用法を説明する。

ピン(3)(4)をはずせば、電極(11)や触媒(13)と共に容器(2)を基盤(1)等からはずす事が出来、ガラス管(9)内に重水(10)を注入し、容器(2)をかぶせる。

図示しないが、ポンプ(20)に付属する圧力調節ベンを数気圧に設定し、ポンプを作動すると、ボンベ(19)内の重水素が管路(21)を経て、空洞(17)内に入り、空洞(17)内の空気は上部にたまる重水素に押され、基盤(1)と容器(2)の隙間から外へ出る。

空気が出きった時、ピン(3)(4)をさし、基盤(1)と容器(2)の接触面を気密に固定すると、以後空洞(17)内は数気圧の重水素で満たされ、重水(10)は数気圧に加圧される。

ついで、電源ボックス(18)から、図示しないスイッチ等を操作し、コイル(6)に数10～数100KHzの高周波交流を流し、磁歪振動子(5)を伸縮させると、パラジウム電極(7)は上下に同周波数で振動し、重水(10)中に強力な超音波が発生する。

この超音波を持続的に発生させた状態で、電源ボックス(18)内の直流電源回路から数10vの電圧をパラジウム電極(7)（陰極）とプラチナ電極(11)（陽極）にかけ、通電し、パラジウム電極の表面で電気分解による重水素を発生させ、プラチナ電極の表面で酸素を発生させる。

発生した重水素の一部は直ちに重水中に溶け込んでしまう。既に、空洞(17)内は数気圧に加圧されており、発生した水素は重水中に溶け込み易い。

また、電極(7)は超音波振動をしており、重水(10)中にキャビテーションを生ずる。

今、重水中での音速を1500m/sec、電極(7)～(11)間の距離を30mm、超音波の周波数を100KHzとすれば、両電極間には定在波が生じ、波長15mmの波が二つ入り、両電極面と、その間の３箇所の合計５箇所がノードとなり、その５箇所で毎秒十万回、高圧になったり、負圧（静水圧以下）になったりする事を反復する。

一負圧になる時、重水中に溶け込んでいる重水素が気化して多数の気泡を生じ、その気泡は100nm程度の直径にまで成長しては、気泡と液体の界面に働く表面張力や静水圧により、１μs程度の短期間に急速に縮小し、いわゆる圧壊を起こし、気泡内の重水素を数百気圧程度の高圧に圧縮する。

このキャビテーションはパラジウム電極の表面と重水の界面ででも起こり、高圧の重水素ガスが押しあてられる事になり、パラジウムの持つ水素原子の吸蔵作用が促進されたり、高密度に吸蔵される可能性を高める等の効果が働き、従来の電気分解のみによって生ずる重水素をパラジウムに吸蔵させる実験より高密度に重水素を押し付ける事が出来、核融合を起こす可能性も高くなる。（気泡の圧壊の際の短期間に生ずる発生期の重水素や圧縮による数千度の温度上昇でプラズマを生じ、イオン化した重水素原子等もパラジウム面に押し付けられる。キャビテーションとは無関係に静水圧と吸着力のみによって押し付けられるのもある。）

核融合が起こったかどうかは、空洞(17)中や容器(2)外に設けた中性子検出器、γ線検出器、重水(10)に加えた電力や超音波エネルギー、水温、その他を測定して判定すればよい。

これらの実験中、管(15)(16)を通じ、冷却水を上盤の内空(14)に流し、容器(2)内を冷却する。

電極(7)と(11)で発生した重水素と酸素の一部は重水（１０）中で化合し、元の重水に戻る。気泡となって重水(10)中を上昇し、触媒(13)に達したものは、触媒の作用で反応し、元の重水に戻り、重水(10)中に落下する。

従って、酸素が空洞(17)中に入り、爆発を起こす危険性は生じない。

重水(10)の静水圧を数気圧に加圧しているため、キャビテーションにより生ずる超高圧も増加する。

しかし、ポンプ(20)の圧力調節ベンの設定を替え、空洞(17)内の空気をまず排除し、ついでボンベ(19)内の重水素を送気し、空洞(17)内を大気圧より、やや低く保ち、小さな超音波エネルギーでキャビテーションが起こるようにしてもよい。

なお、上記の実施例は種々の設計変更が可能である。

例えば、磁歪振動子(10)の代わりに電歪振動子を用いたり、セラミック製または表面を絶縁体で被覆した金属管をプラチナ電極(11)の周囲から下垂し、その内部で超音波の定在波が生じ易いようにしてもよい。

電極(7)を直径1μm以下のパラジウムの微粒子を焼結した多孔性材料で造ったり、パラジウム以外の任意の材質で造ってもよい。

例えば、重水素と核融合を起こし易いリチウムとパラジウムの焼結合金、リチウムとアルミニウムの合金、その他を用いたり、重水(10)中に重水素を含む水酸化リチウムを飽和に到るまで加えた上、電極(7)上に水酸化リチウムの結晶膜を張り付ける等してもよい。

重水(10)中に直径1μm程度のパラジウム、水酸化リチウム等の微粒子（飽和溶液中に）を分散させておき、キャビテーションによる衝撃がそれら微粒子の表面に集中するようにしてもよい。

ガラス管(9)の底をふさぐシリコーンゴム盤(3)に金属薄板等にしてもよいが、上面を円錐形に凹ませているため、重水(10)中に加えた微粒子が電極(7)上に沈殿し易い。

電極(7)と(11)間の通電を、適度の位相差を含んだ、電極(7)の振動数と同周波数のパルス通電にし、キャビテーションの気泡の収縮時に電気分解による重水素が発生するようにする等してもよい。

装置全体を極低温の環境下に置き、重水(10)の代わりに、冷却して液化した重水素または重水素と三重水素の混合液、更にそれらにリチウム、重水素化リチウム、パラジウム等の微粒子を加えた液等を入れ、電極(7)を振動させ、キャビテーションを起こさせ、高圧の生ずる時期に同期して電極(7)-(11)間に高電圧パルスを加え、キャビテーションにより電極(7)に衝突する高圧水素に、電気的な加速が加わるようにしてもよい。

この場合、電極(7)-(11)間の距離を接近させ、リチウム、重水素化リチウム等で電極を造る等してもよい。（リチウムは水と化学反応を起こし易いが、液体水素とは反応しがたい。）重水(10)の代わりに液化した塩化水素、アンモニア、その他を用いてもよい。（これらの液に少量の重水素を溶解させておいてもよい。）

管)内に液体を入れず、常温、常圧、または低圧の重水素ガスを入れ、超音波振動は用いず、高圧の直流通電またはパルス通電をし、重水素のイオンをパラジウム、リチウム、両者の合金等で造られた電極(7)に衝突させる実験をしてもよい。

第3～4図示の装置は油圧プレスにより高圧を造り出す場合を示し、(22)は金属製のフレーム。(23)はその上に取り付けたセラミックス等から成る絶縁盤。(24)はその上に取り付けた硬質合金製のシリンダー。(25)はその底面上に取り付けた直径1cm程度の円盤形パラジウム電極。(26)はシリンダーの内面を包む電気絶縁性で硬質のセラミックス等から成り、上部内面は円錐形をなす絶縁円筒。(27)はその中に入っている重水。(28)はその上方にあるピストン。(29)はフレーム(22)に取り付けられ、ピストン(28)をはめ込んだ油圧シリンダー。(30)はその上端に連なる管。(31)はシリンダー内の油である。

この装置を用いる場合、ポンプにより管(30)を通じ、シリンダー(29)内の油(31)を抜き取り、ピストン(28)を引き上げ、円筒(26)内に水酸化リチウム等を加えた重水(27)をやや多めに入れ、シリンダー(29)内に油(31)を注入し、ピストン(28)を押し下げ、余分な重水を排出させながら、ピストンの下端を電極(25)に接近させ、重水を数万気圧に加圧する。

ついで、数kVの直流電源、または数100kVのパルス電源の陽極にピストン(28)をつなぎ、陰極に電極(25)をつなぎ、重水(27)に通電し、生じた発熱で重水(27)の圧力を更に高め、生じる重水素をパラジウム電極(25)に押し付ける。

この場合も、電極(25)の材質その他を任意に選んでもよい。

シリンダー(24)と絶縁円盤(23)との間隔を広げ、シリンダー(29)及びピストン(28)と同様の物で、シリンダー(24)の下面に開けた穴を通し、電極

(25)を押し上げ、重水(27)を上下から加圧してもよい。

重水(27)に高電圧パルス通電をすると同時に、シリンダー(29)中に高圧空気を送り込み、重水(27)を衝撃的に加圧してもよい。

1m立方の鋼鉄塊の各面の中央に直径と長さが10cmの円柱形の空洞を開け、それらの先に、先端が鋼鉄塊の中心に達っする円錐形の空洞を開け、中心部には直径1cmの中心空を設け、中心空付近の内面はパラジウム鍍金し、その他の空洞の内面は絶縁材で被覆し、重水またはパラジウムコロイドを含む重水を入れ、各円柱形空洞には直径と長さが10cm径の円柱形のピストンを半ばつめて重水の漏れを防ぎ、鋼鉄塊とピストン間にパルス通電し、重水を電気分解すると同時に、6台のエアーハンマーで全ピストンを中心空に向かって叩き、重水中に収縮型の衝撃波を進行させ、中心空に高圧を発生させてもよい。

この場合、中心空に、外径は2mm、内径は1mm程度で、内部は真空の重水素化リチウムの球を入れ、爆縮させ、核融合が起こるか実験してもよい。

この重水素化リチウム球を炭素球等に代え、人工ダイアモンドの合成等を行なってもよい。各ピストンの内面を浅い凹面にする等して、爆縮波を球面にする事が望ましい。

8方向、12方向等から、このような加圧を行なってもよい。

第5～6図は高圧水素ガス中に線状通電を行ない、各融合を行させる実験装置を示し、(32)は肉厚数10cm、内径数10cm、全長数mのチタン合金、ジルコニウム、その他の耐熱性で強靭な材料から成る円筒形の耐圧容器。(33)(34)は耐圧容器の両端に開いた直径10mm程度の穴をふさぎ、紫外線を通し、かつ電気絶縁の機能も兼ねた石英その他の材料から成る窓ガラス。(35)(36)は窓ガラスの内方の凹み中に置かれ、内面は浅い円錐形をなし、中心には、外端が10mm程度、内端が1mm程度の直径の円錐形の中空を有する金属製円筒電極。(37)(38)はこの電極から延び、容器(32)の外へ突出したリード線。(39)(40)は容器(32)内に通ずる管。

(41)(42)は直径10mm程度の紫外線ビームを出す、色素レーザーその他の紫外線レーザー。(43)(44)は直径1mm程度の紫外線ビームを出す紫外線レーザー。(45)(46)はそれらレーザーの励起用光源である。

管(39)と(40)を通じ、ポンプで容器(32)内に重水素と三重水素の混合ガスを数千～数万気圧になるよう詰め、光源(45)(46)にパルス通電し、強い励起光を発生させ、レーザー(41)～(44)を励起し、容器(32)の軸方向に強い紫外線ビームパルスを発生させる。

レーザー(41)(44)から出る紫外線ビームは直径10mm程度であり、窓ガラス(33)(34)を通った後、電極(35)(36)の円錐形の内空に入り、その内部に入っている水素ガス中の一部の原子を電離させ、導電性を持ったプラズマにする事を主な機能にしている。

レーザー(43)(44)から出る紫外線ビームは直径1mm程度であり、レーザー(41)(42)から出たビームの一部と共に、電極(35)(36)の内端の小孔を通り、容器(32)内の水素ガスの中心軸に細いプラズマを通り、両電極間に金属線を張ったような電路を形成させる。

図示しないが、数10kv～数100kvの直流電源に連なるコンデンサー電源の陽極はリード線(37)を通じて電極(35)に連なり、陰極はリード線(38)を通じて電極(36)に連なっているため、紫外線照射を受けて導電性を与えられた水素ガス中にコンデンサーから、数クーロン～数千クーロンの電子が電極(36)→電極(35)に流れ、質量が大きいため動きにくい重水素と三重水素の原子核である陽イオンが、電極(35)→電極(36)の方向に小量流れる。

今、1kCの電子が、電極(35)～(36)間の平均電位差を100kvで、1μsの期間に流れたとすれば、その平均電流は1GAとなり、発生するエネルギーは100MJとなる。

通電部は高温となり、多量の電磁波が発生し、かつ強磁場を起こす。

電磁波の多くは壁面に磨かれた円筒形容器(32)の内面で反射され、再び容器(32)の中心軸に集中

するので、中心部を高温にする上に役立つ。

球状の中心部が高温になると、爆発的な熱膨張が起こり、衝撃波が半径方向に広がり、容器(32)の内面で反射され、中心軸の方向に折返し、中心部に再び集中する。

衝撃波が中心に向かう際、円筒形の波面はしだいに直径が縮小し、爆縮を起こし、本もと高圧がかかっており、液体に近い高密度状態の容器(32)内の水素ガスの中心部に超高圧、高密度、高温の球状部を発生する事になり、重水素と三重水素の原子核の核融合を起こす可能性が生じて来る。

衝撃波の反射波が容器(32)の中心部に集中する時期に同期して、光源(45)(46)に通電し、紫外線ビームを容器(32)内に送り込めば、前の放電で一旦電圧が下がった後、直流電源から給電され、電圧を回復しているコンデンサー電源からの再放電が起こり、前より高い温度での爆発が中心部に起こり、反射波の爆縮による到達密度や温度も前より高くなる。

核融合による発熱が生じている場合には、その温度上昇等もいっそう大きくなる。

従って、光源(45)(46)へのパルス通電を反復すれば、更に温度を上昇させる事が出来る。

中心部の到達最高温度の上昇要因の内のエネルギー源は、レーザー(41)～(44)からの光、電極(35)(36)間の通電電力、核融合により発生する熱等であり、下降要因の内のエネルギーの放散経路は、中心部から周囲のガスへの熱伝導、ガスから容器壁等への熱伝導、中心部から発生した電磁波の容器壁での吸収、透過、核融合で発生した高速度中性子やヘリウム原子核の飛散等である。

その他の上昇、下降の要因として、容器(32)の内面の直径、長さ、真円性、電磁波及び衝撃波の反射率、電極(35)(36)の形や反射率、紫外線ビームの太さ、電源コンデンサーの容量、電圧、通電時間、通電時期の位相や回数、ガスの成分、圧力、温度、それら要因の影響も受ける衝撃波面の真円性や圧縮部の圧力、厚み、ガス中の放電路の電気抵抗値、ピンチ効果による放電路の縮小、熱解離や通電時の荷電粒子の衝突、電離による放電路の拡大、その他が影響を及ぼす。

反復通電による温度上昇により、容器(32)の壁面で反射されないx線、γ線、中性子等の発生が増加し、上昇要因と下降要因が平衡し、温度上昇は一定値にとどまる。

極端に大きなエネルギーを投入しない限り、中心部にかなり高い確率で核融合が起こったとしても、熱膨張により中心部の温度と密度はただちに下がり、容器内の全水素ガスが連鎖反応を起こして核融合するには到らない。

核融合の起こる頻度を制御するには、レーザー光量、通電量、容器内圧、ガス成分、反復レーザー光照射のタイミング等を変えればよい。

電極(35)(36)の内方のごく近くで生じた通電時の膨張波は半径方向に広がり、やがて電極の円筒面にぶつかり、反射の法則に従い、方向を変え、電極から離れた円筒(32)の中心軸上に焦点を結ぶ。

従って、電極の近くには爆縮の収束波が集まらず、電極材料を加熱する事が防がれる。

また電極の内空が円筒形になっており、比表面積が広いため、面を通過する電流密度や、ぶつかる電子密度、陽イオン密度等が小さく、発熱が分散され、電極材料の溶融等を防ぐ事が出来る。

なお、この実施例も種々の設計変更が可能である。以下その概要を記す。

例示したサイズ、容器(32)内の圧力、通電条件、その他の値を任意に上げ下げし得る。

冷却、あるいはエネルギーを取り出すため、容器(32)を水槽中に沈めたり、容器壁中に設けた空洞に冷却液を循環させたり、管(39)(40)を通じ、水素ガスをラジエーターに循環させてもよい。

容器(32)の外面に多数のフィンを設け、容器壁の放熱性や強度を増してもよい。

レーザー(43)(44)を直径の太いビームを出す物にし、まず凸レンズで微小焦点にしぼり、凹レンズで細い平行光に変え、レーザー(41)(42)に送り込むようにしてもよい。そのビームの直径は0.1mm以下であってもよい。

レーザー(41)～(44)中に通電し、励起する方式の素材を用いれば、光源(45)(46)は不要となる。自

由電子レーザーその他で紫外線を出してもよい。

レーザー(41)(42)は、その出力光の大部分が電極(35)(36)中の空洞内のガスに吸収される波長の範囲を選び、斜め方向から出力光を容器(32)中に送り込み、レーザー(43)(44)の出力光の進路中に装置本体が入らないようにしてもよい。

紫外線ビームの代わりにシンクロトロン放射光発生装置その他から出るx線やγ線のビームを用いてもよい。

ネオジウムガラスレーザー等、可視光や赤外光のレーザーを用い、水素ガスを高温に加熱し、熱解離により、導電性を与えてもよい。

窓ガラス(33)(34)を可視光を受けて紫外線を発生する材質にしたり、光路上の窓ガラスと電極(35)(36)の境界部に凸レンズや凹レンズを設け、光ビームの調整を行なう等してもよい。

電極(35)(36)の局所的な高温化を防ぐため、電極外や自体の中に設けた空洞中に金属ナトリウム液その他を入れ、対流、外部磁場の変化による流動等により、移動し、冷却してもよい。

容器(32)の中心軸より10cm上方に中心軸を持つ直径30cm程度の円柱形金属塊を電極(35)(36)の中に納め、円柱の、軸から半径方向に10cm離れた位置に直径10mm程度の穴を多数開け、レンコン状の内部電極を形成させ、その内の一つの穴を光のビーム及び電流が通るようにし、時々この内部電極を回転させ、異なった穴から放電を起こさせ、極端な温度上昇を避けてもよい。

電極(35)(36)の内面を電流の通路のみに穴を開けた絶縁板で被覆してもよい。

内部に直径10mm程度の一様な穴の開いた左右長数mの細手の金属管や炭素管を電極(35)(36)として用い、それらの外端に連なるリード線(37)(38)から通電し、両電極の全長にわたる広い管内面から、ほぼ均等に通電され、局所的な加熱を防いでもよい。

この場合、両電極の内方に電子凸レンズ（収束コイルその他）を設けて電極から飛び出す荷電粒子ビームを円錐形にしぼってもよい。

その他、電極(35)(36)の加熱や損耗を防ぐための種々な工夫がなされる必要がある。

電極(35)(36)を通った荷電粒子が窓ガラス(33)(34)に激突し、くもらせる事を防ぐため、電極と窓ガラスの間を開け、光路線と直角方向の磁場を働かせ、荷電粒子の進路を曲げたり、自動的にくもりを除く装置を設けたり、前記の内部電極と同様、時々回転させ、荷電粒子のぶつかる場所を替えて行く小窓ガラスを設ける等してもよい。

容器(32)の外側にコイルを巻き、直流通電して左右方向の磁場を形成させ、放電路が広がるのを防いでもよい。

電極(35)(36)の通電をサイラトロンその他のスイッチで制御してもよい。その際、レーザーの電源、電極(35)(36)と スイッチ等を直列につないでもよいし、水銀蒸気レーザー中に熱陰極とコントロールグリッドも封入した、サイラトロン兼用の紫外線レーザーと電極(35)(36)を直列につなぐ等してもよい。

容器(32)内の一点に多数のレーザービームを交差させ、各ビームにそれぞれ通電し、一点のみ高温にしてもよい。この場合、電源や電極も各ビームに固有の物を用いる。

容器(32)の外面に取り付けた圧電素子に加わる衝撃や、窓ガラス(33)(34)を通して漏れ出る容器(32)内に発生する電磁波を受ける光電素子等の出力をA－Dコンバーターを介してコンピューターに加え、容器(32)内で起こる爆発や衝撃の大きさ、爆発時点等を算出し、一定時間を経て、コンピューターから紫外線ビームを出す起動出力信号を発生させる等の制御を行なってもよい。

整流器を介して交流電源に連なる大型平滑コンデンサーを設け、各々コイルを介して平滑コンデンサーに連なる多数のパルス電源用コンデンサーを設け、スイッチを介して、順次、パルス電源用コンデンサーをレーザービーム照射に同期して、電極(35)(36)に加えて放電させるようにすれば、各コンデンサーが次の放電の順番になるまでの間に、各コイルを介して平滑コンデンサーから充電されており、電極(35)(36)に数KHzの周期で反復放電される事も可能になる。

この場合、各コイルは一つの電源コンデンサーが電極(35)(36)につながれた為、大本の平滑コンデンサーまでが電極(35)(36)に直結される事を防いでいる。かつ、抵抗器のように発熱しない。平滑コンデンサーを直結すれば、大電気量を流し得るが、再充電に時間がかかり、短周期の反復通電が出来ないし、パルス幅が広くなる。平滑コンデンサーの容量を小さくして時定数を小さくしようとすれば、交流電源のリップルが目立って来る。

容器(32)の内径、その他の条件により異なるが、中心から起こった爆発が反射され、再び中心に集まるまでの周期は短く、周波数は数KHzとなる。

水素は超高圧にすると金属のように導電性を持つ事もあり得るが、その場合には容器内圧や温度を適度に下げる必要がある。

爆縮により中心部付近が高圧、高温になり、熱解離が起こる場合、紫外線を当てなくても通電可能になるが、その場合には、低電圧、大電流の電源から通電し、容器(32)の中心部から離れた温度が低く、抵抗値の高い部分には、電流が流れにくくなるようにしてもよい。

容器(32)を内径数10cm程度の球形にし、外径が10mm程度で内径1mm以下の中空を有し、外面には絶縁被覆を施し、中空の一端から数cmの部を除いて石英ガラスを詰めてなる長い電極を数百対、適度に分散させ、石英ガラスの詰まっている側の端が容器の中心に向かい、かつ容器の内面に一致するよう、容器壁中に取り付け、対照の位置にある電極対の外端をそれぞれ独立の電源につなぎ、石英ガラスを通じて一斉に紫外線ビームを送り込み、容器内の中心部にビームを集中させ、かつ通電し、中心部を高温にし、爆縮波が中心の一点に集まる時期に再通電を繰り返すようにしてもよい。

この場合、電極の内外径をもっと太くし、1～数対のみ用いる際は、凸レンズを用いて紫外線ビームが容器の中心に集中するようにする。

あるいは、フランジ付の二個の半球形容器を、輪状の絶縁板を挟んで合わせ、両フランジを絶縁被覆した多数のネジで止め、各容器半球を電源の陽極と陰極につなぎ、各半球に、中心部に向かう多数の細い貫通孔を開け、石英ガラスを詰め、全石英ガラスに紫外線パルスを送り込み、両容器半球間に、多数の紫外線ビームを通じ、中心に集中する通電を行ってもよい。

非強磁性の金属で球形または円筒形の反応容器を造り、内部に空気、ヘリウム、純水、その他の透明度が高く、核融合を起こしがたい流体を詰め、数万気圧に加圧する。

容器外のレーザーから容器内の中心にレーザー光を集中するためのレーザー光照射窓を容器壁に多数設ける。

容器の上部に流体の送入口を設け、下部に排出口を設け、容器内の上から下に向かう流体の流れを造る。

極低温環境下で重水素と三重水素の混合気を直径数mm以下の球体にし、その外面を、表面を黒色に塗った強磁性金属の球形容器で囲み、燃料ペレットを造る。

この燃料ペレットを容器上部の送入口から流体の流れに乗せて容器の中心部付近へ送り込む。

レーザー光照射窓または容器壁に設けた別の観測窓を通して弱い光を送り込み、容器内のペレットの位置を自動測定し、容器外に設けた多数の電磁石の通電バランスを制御し、容器内のペレットの位置を磁力で移動して制御し、ペレットが容器の中心部に到った時点で、強力なレーザーパルスをレーザー光照射窓を通して容器内に送り込み、ペレットの表面を瞬間的に超高温に加熱する。

周知のレーザー核融合の原理でペレットは爆縮を起こし、核融合エネルギーを発生する。

ペレットを送入口から容器内に入れた時、ペレット中の固形化した水素は温度上昇により、気化しようとするが、容器内の流体が高圧であるため、ペレットの気化は防がれる。

ペレットはレーザー照射で蒸発飛散するが、周囲の流体に吸収され、流体と共に容器外に排出され、従来のレーザー核融合装置のように、窓ガラスや反応容器壁が汚染される事がない。

また、高圧流体環境下でレーザー照射を行なうため、爆縮による到達最高圧や最高温度も高めら

れる。

なお、この場合も、レーザー照射と同時に、レーザー光の通路を介し、ペレットに通電してもよい。

反応容器内に通ずる高圧気体環境下で、ペレット用金属容器内に、高圧の水素を詰め込み、ペレットを造ったり、常圧下で、重水素化リチウムの球体の表面に金属容器をかぶせる等して、ペレットを造ってもよい。

その他種々の設計変更が可能である。

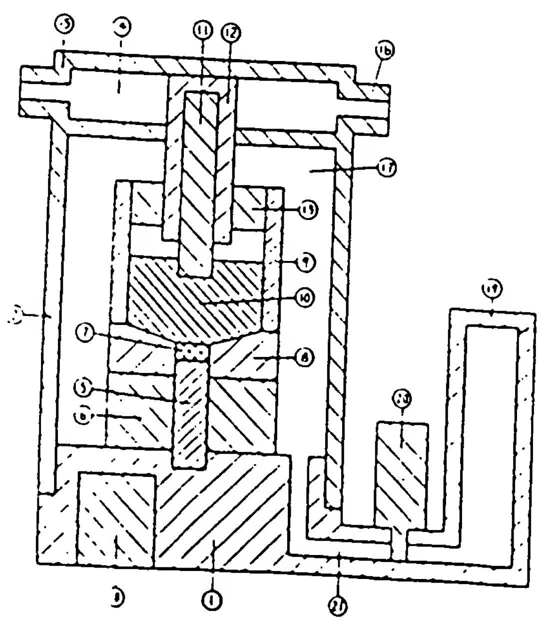
本発明を実施すれば、電気分解を利用したり、高温高圧を利用したりする核融合実験装置に、従来の方式とは異なった手段で、比較的安価に、加圧条件を加える事が出来るようになる利点が生ずる。

4　図面の簡単な説明

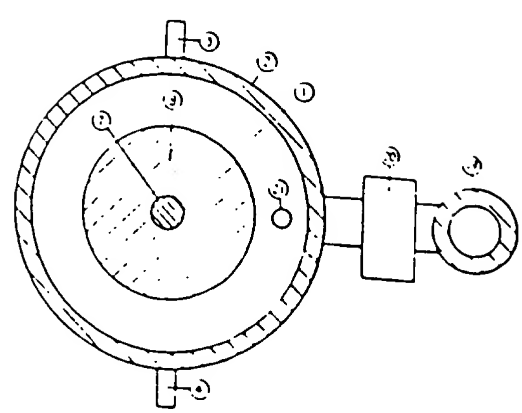
第1図は本発明の第1実施例の縦断面図。第2図はその横断面図。第3図は第2実施例の縦断面図。第4図はその横断面図。第5図は第3実施例の縦断正面図。第6図はその縦断側面図である。

原村明宏

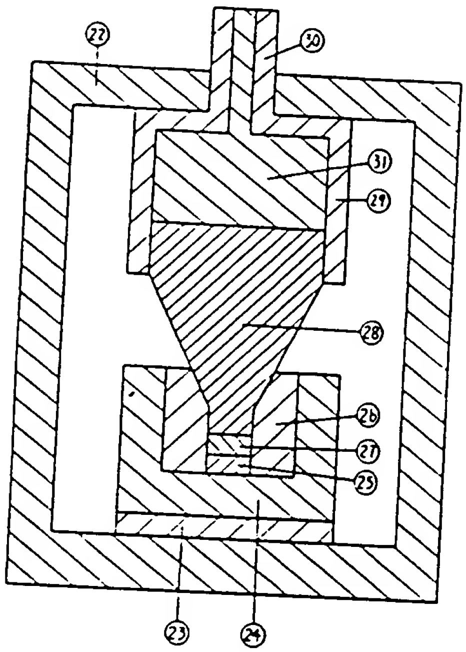
第1図



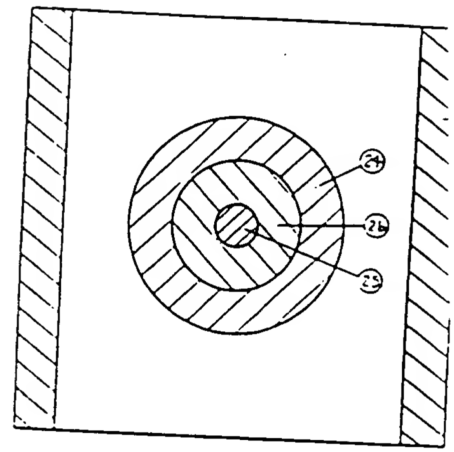
第2図



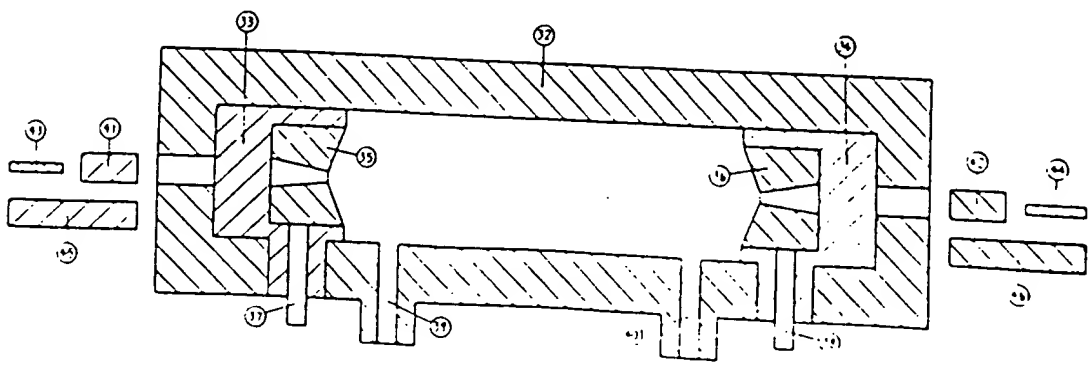
第3図



第4図



第5図



第6図